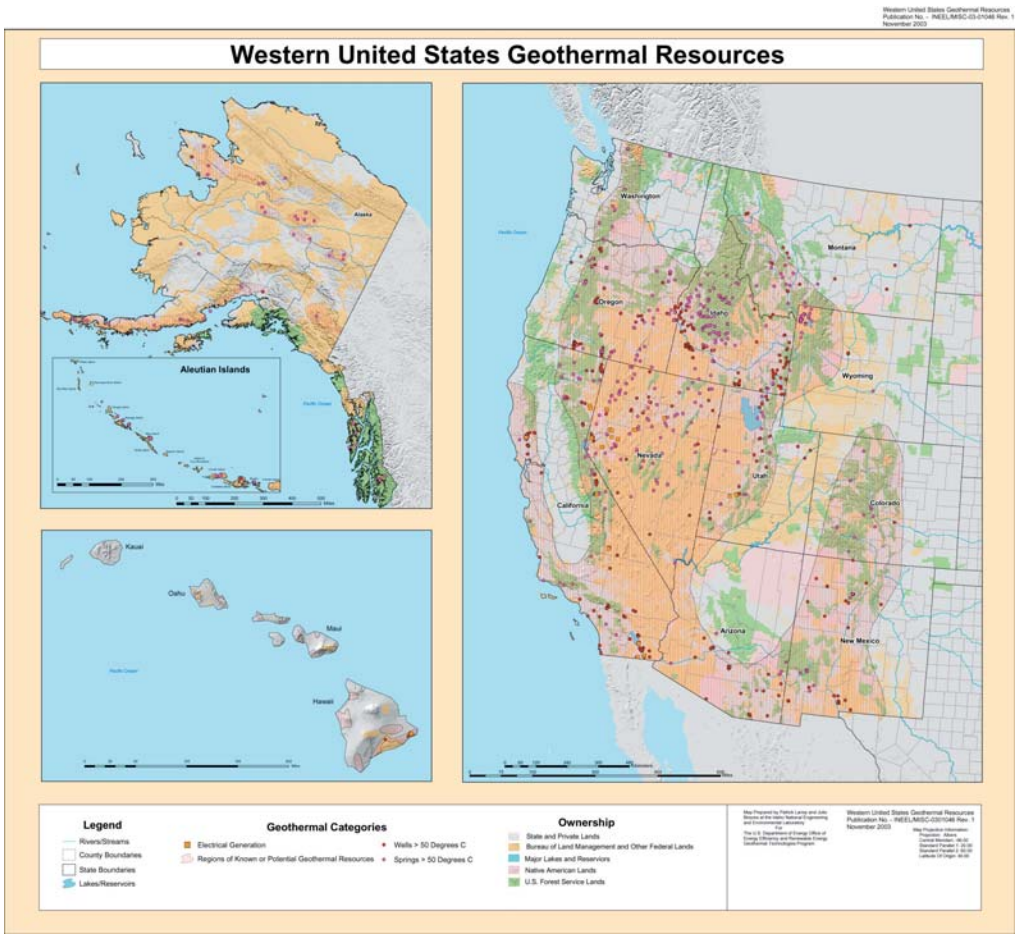
What is geothermal energy?

Geothermal energy is literally heat from the earth. Temperature increase gradually with depth from the surface due to the immense heat from the earth's interior. Heat is continuously transferred up from the mantle into the earth's crust and is also generated from the decay of radioactive elements in the crust. While this energy is manifested at the earth's surface in various forms, it is most usable when associated with water in the form of steam or hot water, which can have a temperature as high as 350°C (660°F) or more



Geothermal Energy for Mining Applications

science

INL Idaho National Laboratory

Where is geothermal energy?

Near-surface heat anomalies associated with major geothermal resources are primarily concentrated near the boundaries of tectonic plates and mantle hot spots. They can also occur at other places where the earth's crust is thinned or fractured. When these heat anomalies occur in the presence of water and rock with sufficient permeability, hydrothermal systems are formed. These hydrothermal systems are sometimes evidenced by surface expressions such as geysers, funaroles (steam vents), and hot pools. (Mining exploration is often associated with the effects of such hydrothermal systems on rock alteration.) There are extensive areas in the western United States with significant geothermal resource potential.

How can geothermal resources be used?

Geothermal resources can be used to make electricity (through steam, flash steam, or binary plant processes) or for so-called direct use applications (including industrial processing, district or space heating, agriculture, aquaculture, and recreation). Electricity produced with geothermal resources can provide power for mining operations. Lower temperature geothermal fluids can be used in mining for heap leaching, drying operations, and space heating. These lower temperature resources can come directly from the geothermal reservoir or as the "spent fluid" from geothermal electricity produc-

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tion (cascaded use). Geothermal fluids can also be an "ore" for contained dissolved solids. For example, extraction of zinc from geothermal fluids at the Salton Sea in California produces about 33,000 tons of high-quality zinc per year, with associated facilities generating 49 MW of geothermal electricity.

What are the benefits of geothermal energy?

Geothermal energy is a clean, reliable, renewable resource. Steam and flash steam geothermal electric plants produce comparatively minute air emissions (such as carbon dioxide) while binary plants produce essentially no air emissions since the geothermal fluid is injected back into the reservoir after use. Hydrogen sulfide is normally removed from geothermal fluid condensate in steam and flash steam plants. Injecting spent geothermal fluids back into the reservoirs from which they came eliminates a waste fluid disposal problem while also helping to sustain the resource's production. Geothermal facilities make little noise and require relatively small amounts of land. In addition, the "fuel" (geothermal fluids from which energy is extracted) is free and eliminates operational uncertainties associated with the variable cost of other forms of energy.

The Idaho National Laboratory (INL0 is a U.S. Department of Energy (DOE) national laboratory located in Idaho Falls, Idaho. The INL is a leading national laboratory in the DOE Windpowering America activity and has significant capabilities and experience in the integration of wind energy into power systems for remote areas.

The Mammoth-Pacific binary plants, located in Mono County, California, have a 25-megawatt net generating capacity and occupy 10 acres with 12 production and 6 injection wells.